Fisheries and Oceans Canada | Pêches et Océans Canada
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Canadian Science Advisory Secretariat (CSAS)

Proceedings Series 2015/066

Pacific Region

Proceedings of the Pacific regional peer review on the Evaluation of Marine Recreational Coho Mark Selective Fisheries in British Columbia, including an evaluation of the Canadian marine fishery exploitation model for Interior Fraser Coho

March 3-5, 2015
Nanaimo, British Columbia

Chairperson: Dr. Jeffrey Lemieux
Editors: Nicholas Komick and Mary Thiess

Fisheries and Oceans Canada
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December 2015

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/
csas-sccs@dfo-mpo.gc.ca

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ISSN 1701-1280

Correct citation for this publication:

DFO. 2015. Proceedings of the Pacific Regional Peer Review on the Evaluation of Marine Recreational Coho Mark Selective Fisheries in British Columbia, including and evaluation of the Canadian marine fishery exploitation model for Interior Fraser Coho; March 3-5, 2015. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2015/066.

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SUMMARY

These Proceedings summarize the relevant discussions and key conclusions that resulted from a Fisheries and Oceans Canada (DFO), Canadian Science Advisory Secretariat (CSAS) Regional Peer Review meeting of March 3 to 5, 2015 at the Vancouver Island Conference Centre in Nanaimo, BC. Two working papers titled "Interior Fraser River Coho Exploitation Rate Estimation Methods" and "Evaluation of Marine Recreational Coho Mark Selective Fisheries" were presented for peer review.

In-person and web-based participation included Fisheries and Oceans Canada (DFO) Science and Fisheries and Aquatic Management Sectors staff; and external participants from First Nations organizations, the commercial and recreational fishing sectors, and academia.

The conclusions and advice resulting from this review will be provided in the form of one Science Advisory Report providing advice to Fisheries Management and Salmon Enhancement Program to conduct a review of Coho Mark Selective Fisheries program to evaluate its effectiveness and utility as a management tool. As exploitation rate is a key metric necessary to respond to this request, it was recognized that a review of the exploitation rate forecast and estimation methods was required. This assessment, and advice arising from this Canadian Science Advisory Secretariat (CSAS) Regional Peer Review (RPR), will be used to inform the overall evaluation of the MSF program, the development of Integrated Fisheries Management Plans (IFMPs) for southern BC salmon and the assessment of Interior Fraser River (IFR) Coho.

The one Science Advisory Report and one supporting Research Document will be made publicly available on the Canadian Science Advisory Secretariat (CSAS) website.

Compte rendu de l'examen par les pairs sur l'évaluation des pêches maritimes récréatives et sélectives de saumon coho en Colombie-Britannique, incluant une évaluation du modèle canadien d'exploitation de la pêche maritime de saumon coho du Fraser intérieur ; du 3 au 5 mars 2015

SOMMAIRE

Le présent compte rendu résume les discussions pertinentes et les principales conclusions de la réunion régionale d'examen par des pairs du Secrétariat canadien de consultation scientifique (SCCS) de Pêches et Océans Canada (MPO) qui a eu lieu du 3 au 5 mars 2015, au Vancouver Island Conference Centre de Nanaimo, en Colombie-Britannique. Deux documents de travail intitulés « Interior Fraser River Coho Exploitation Rate Estimation Methods » [Méthodes d'estimation des taux d'exploitation du saumon coho du Fraser intérieur] et « Evaluation of Marine Recreational Coho Mark Selective Fisheries » [Évaluation des pêches maritimes récréatives et sélectives du saumon coho] ont été présentés aux fins d'examen par les pairs.

Au nombre des participants en personne ou par conférence Web, il y avait des employés des secteurs des Sciences et de la Gestion des pêches et de l'aquaculture de Pêches et Océans Canada (MPO), des participants externes provenant d'organisations des Premières nations, des secteurs de la pêche commerciale et récréative et des universités.

Les conclusions et les conseils découlant de cet examen seront présentés sous la forme d'un avis scientifique, lequel fournira des conseils à la Gestion des pêches et au Programme de mise en valeur des salmonidés en vue d'effectuer un examen du programme sur les pêches sélectives de saumon coho pour évaluer son efficacité et son utilité en tant qu'outil de gestion. Comme le taux d'exploitation est une mesure clé nécessaire pour répondre à cette demande, il a été reconnu qu'un examen des méthodes d'estimation et de prévision du taux d'exploitation était requis. La présente évaluation et l'avis découlant de cet examen régional par les pairs du SCCS serviront à orienter l'évaluation globale du programme de pêche sélective, l'élaboration des plans de gestion intégrée des pêches (PGIP) pour le saumon du sud de la Colombie-Britannique et l'évaluation du saumon coho du Fraser intérieur.

L'avis scientifique et les deux documents de recherche à l'appui seront rendus publics sur le site Web du calendrier des avis scientifiques du Secrétariat canadien de consultation scientifique (SCCS).

INTRODUCTION

A Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS), Regional Peer Review (RPR) meeting was held on March 3 – 5, 2015 at the Vancouver Island Conference Centre in Nanaimo to review the use of Coho mark selective regulations in marine recreational fisheries and to provide estimates of Interior Fraser River (IFR) Coho exploitation rates using the IFR Coho Marine Fishery Planning tool.

The Terms of Reference (TOR) for the science review (Appendix A) were developed in response to a request for advice from Fisheries Management. Notifications of the science review and conditions for participation were sent to representatives with relevant expertise from First Nations, commercial and recreational fishing sectors, environmental non-governmental organizations, and academia.

The following working papers (WP) were prepared and made available to meeting participants prior to the meeting:

> Interior Fraser River Coho Marine Fishery Planning Model and Updated Exploitation Rates by Pieter Van Will, Wilf Luedke, and Diana Dobson (CSAP 2013SAL005a)
>
> Evaluation of Marine Recreational Coho Mark-Selective Fisheries by D.S. O'Brien, K. Hein, J. Sawada, and W. Luedke (CSAP 2013SAL005b)

The meeting Chair, Jeffrey Lemieux, welcomed participants, reviewed the role of CSAS in the provision of peer-reviewed advice, and gave a general overview of the CSAS process. The Chair discussed the role of participants, the purpose of the various RPR publications (Science Advisory Report (SAR), Proceedings and Research Document), and the definition and process around achieving consensus decisions and advice. Everyone was invited to participate fully in the discussion and to contribute knowledge to the process, with the goal of delivering scientifically defensible conclusions and advice. It was confirmed with participants that all had received copies of the Terms of Reference, working papers, and draft SARs.

The Chair reviewed the Agenda (Appendix C) and the Terms of Reference for the meeting, highlighting the objectives and identifying the Rapporteur for each review. The Chair then reviewed the ground rules and process for exchange, reminding participants that the meeting was a science review and not a consultation. The room was equipped with microphones to allow remote participation by web-based attendees, and in-person attendees were reminded to address comments and questions so they could be heard by those online.

Members were reminded that everyone at the meeting had equal standing as participants and were expected to contribute to the review process if they had information or questions relevant to the paper being discussed. In total, 45 people participated in the RPR (Appendix D). Nicholas Komick and Ma y Thiess were identified as the Rapporteurs for the meeting.

Participants were informed that William Gazey and Michael Staley had been asked before the meeting to provide detailed written reviews for the 2013SAL005a working paper to assist everyone attending the peer-review meeting. Similarly, Mike Hawkshaw and Ron Kadowaki provided written reviews of the 2013SAL005b working paper. Participants were provided with copies of the written reviews.

The conclusions and advice resulting from this review will be provided in the form of a SAR to Fisheries Management to inform salmon fishery planning for the above-noted stocks. The Science Advisory Report and one supporting Research Documents will be made publicly available on the Canadian Science Advisory Secretariat (CSAS) website.

REVIEWS - INTERIOR FRASER RIVER COHO MARINE FISHERY PLANNING MODEL AND UPDATED EXPLOITATION RATES

Working Paper: Interior Fraser River Coho Marine Fishery Planning Model and Updated Exploitation Rates. WP2013SAL005a

Rapporteurs: Nicholas Komick and Mary Thiess

Presenters: Wilf Luedke, Pieter Van Will

PRESENTATION OF WORKING PAPER

The presentation of this working paper began with Wilf Luedke providing broader context information and background on the Fishery Regulation Assessment Model (FRAM), used bi-laterally with the Southern Coho Management Plan (Chapter 5) within the Pacific Salmon Treaty (July 2014), and the Interior Fraser River (IFR) Coho Marine Fishery Planning Tool (MFPT). The FRAM model was described as being an abundance-based model, requiring more input data than MFPT. The IFR Coho MFPT model is limited to assessing a single Coho stock, which is the major limiting factor in managing Coho fisheries.

After the first presentation on model context and background, Pieter Van Will presented a summary of the working paper and the IFR Coho MFPT. The presentation began with a review of the model structure, which is a deterministic model that scales base-period exploitation rates using effort and release mortality scalars.

In addition to the basic model structure, the presentation summarized some modifications and updates made to the base period to accommodate known changes in fishing patterns subsequent to the base period. To handle the addition on a Gulf Seine fishery and increase prevalence of offshore West Coast Vancouver Island recreational fishing, the base period was updated using ancillary data or with a different form than standard base-period fisheries. In addition to incorporating additional fisheries into the base period, the model was also modified to handle various other terms, such as Troll Target Scalars and Bag Limit Scalars, to handle fishery changes since the base period.

Furthermore, the deterministic model was run through a Monte Carlo simulation to estimate uncertainty for the model results. During each iteration of the of the simulation, the base period Exploitation Rate was varied based on the range of values estimated in the base period and a release mortality rate was selected from a discrete set of previous identified values.

WRITTEN REVIEWS

Michael Staley

The first review, provided by Michael Staley, looked at the use of the model within context of its potential and appropriate use. Two general purposes of the IFR Coho MFPT were mixed within the paper. The first purpose and the use for which the model was introduced in the paper was as a fishery planning tool. A second purpose, used in certain contexts of the paper, was as a stock assessment tool. Although the model may be appropriate for the first purpose under certain circumstances, it is not appropriate for the second purpose. The reviewer suggests separating out the assessment side for future discussion. A summary of the major points identified by this review are provided below (for full review see Appendix B).

- The model is appropriate for fisheries planning under certain circumstances, but not as an assessment tool.

- Assessment of model assumptions, such as the relationship between effort and exploitation rate, is needed in the paper.
- Release mortality rates in the model should be based on continuous distributions instead of existing discrete distributions.
- More thorough handling and reporting of uncertainty is needed in results to managers.

William J. Gazey

The second reviewer, William Gazey, said he implicitly took the IFR Coho MFPT to be limited to a fisheries planning tool. The model was adequate to support the results, under the constraints of dealing with one stock as by-catch. It is important to clearly state in the paper when the model stops being applicable. For example, when more than one stock is of concern in fishery planning, then this model should no longer be used. However, the paper cannot venture beyond identifying these limits as the subject become more difficult and beyond the scope of this paper. Some independent data is needed to go from planning to assessment. A summary of the major points identified by this reviewer are provided below (for full review see Appendix B).

- A sensitivity analysis is needed for estimates of release mortality rate and the paper should highlight that this is a significant source of uncertainty in the model.
- Update the 2014 data in the paper.
- The paper would be easier to read with defined Introduction, Results, and Discussion sections.
- Identify when the model stops being applicable (e.g. multiple stocks are a concern).
- The paper needs to define what is meant by IFR Coho not being prevalent in northern fisheries.

GENERAL DISCUSSION

In the section below the general discussion that occurred subsequent to the formal reviewers' presentations is provided. Below are the summary points from the discussion. These points are followed by a more detailed description of the major discussion topics.

- More background information and comparison with FRAM is needed in the paper.
- Major model assumptions and the implications of those assumptions need to be more clearly identified.
- Explore other relationships and provide more statistical information between effort and exploitation rates.
- Use fishery mortality rates defined within the Integrated Fishing Management Plan (IFMP) with the associated continuous uncertainty from the original source.
- Coldstream River CWT data should be added to the model base period.
- Uncertainty in source data needs to be more fully represented in the model, including base period uncertainty.
- An exploration separating inside and outside Coho migration year base periods should be undertaken in the paper.
- Model sensitivity analysis is needed to assess the assumptions in the model.

- A discussion on the issue of multiple encounters to a single fish should be added to the paper.

At the beginning of the working paper presentation, background was provided on the origins of the FRAM and IFR Coho MFPT models and their general structural differences. For example, FRAM accommodates multiple stocks and the IFR Coho MFPT model is limited to a single stock. The committee generally agreed that more of the material provided in the presentation should be incorporated into the paper. This would include the fact that FRAM is the bi-lateral tool used for US/Canada assessment and is the key to meeting the 10% Exploitation Rate on IFR Coho agreed to in the Pacific Salmon Treaty. Furthermore, more results from the FRAM model for comparative purposes, such as Exploitation Rates up to 2013, would strengthen the paper.

In terms of model constraints, the committee reiterated that the model is limited to a single stock of concern with low exploitation rates in recent history. It is not a stock assessment tool, as exploitation rates provided by the model are projected and not estimated. Based on this discussion, the reference to estimated exploitation rates in the first objective of the TOR would be beyond the scope of this paper and may be qualified to provide projected exploitation rates. Qualified use of this model should include the caveats that this is a single stock model managed under low exploitation rates and as bycatch.

Furthermore, there was significant discussion regarding the relationship between effort and exploitation rate. This was identified as a significant assumption within the model and that limited discussion was presented in the paper regarding the relationship beyond the linear model used, based on base-period data. The authors identified that the linear relationship used was conservative for the lower effort and exploitation rates commonly observed in current fisheries. However, data in the range of effort values currently observed in fisheries has limited representation within the models. There was some discussion regarding the possible use of using other relationships, such as a curvilinear model, or looking at developing relationships based on individual fishing sectors to possibly capture more recent fishing conditions. The committee agreed that exploration of other relationships should extend to explore curvilinear models and that the paper should provide more statistical information about the effort to exploitation rate models used, such as r^2 and significance values.

In addition to the effort to exploitation rate relationship assumption, the incorporation of uncertainty into model simulations was also highlighted. The model simulations do incorporate some variability with the sampling of discrete distributions from both the base period exploitation rates and release mortality rates. However, the committee identified that the model should incorporate uncertainty related to all model input data, including base-period uncertainty. Incorporating this additional variability into the model will allow users of the model output to better understand the uncertainty in the model output.

Another component identified by the committee that may have substantial impact on model results is the release mortality rate distributions used within the model. Concerns were raised about the suitability of some of the release moralities used in the model. Release mortality rates identified in Cox-Rogers et al. (1999) had been identified as representing northern fisheries and under different fishing conditions than what are typically observed in southern fisheries. The discrete release mortality rate distribution used in the model may not be, as the committee identified, the most appropriate prior probability distribution for use in the model. Evolving research in this field makes it difficult to select an updated distribution for this component of the model within the context of this paper. The suggestion by the committee was to focus on using the values provided through the Integrated Fishing Management Plan (IFMP) with the

associated uncertainty from the original research. A future CSAS process on release mortality rates could better inform the input values for this model component.

The committee also discussed the separation of inside- and outside- year Coho migration within the context of the paper and the model. A discussion regarding inside and outside migration was presented in the paper with identification that the base period includes a range of those migration conditions. The committee determined that the paper should be improved with the exploration of having separate base periods for inside and outside years. Although this may substantially reduce the amount of data available to inform either instance of the base period, it was worth exploring the two distinct IFR Coho distribution patterns. The reduction of data associated with separating inside and outside migration years may be offset, to some degree, by the inclusion of Coldstream River CWT data. This identification of inside and outside years should also be reflected in figures showing relationships between effort and exploitation.

To improve the understanding of the model and its base period, several suggestions and further explanation was requested by the committee on various aspects of the model. How First Nation and test fisheries are incorporated into the model were not identified in the paper. Also, the paper would benefit from more detail on unique components of the model, such as the WCVI offshore recreation fishery and Gulf Seine fisheries. Also, it hasn't been identified in the paper how recent reductions in the creel programs and the associated effort estimates are potentially interpolated for use within the model. The paper also noted explicit exclusion of northern fisheries, but there was limited documentation or rationale for why they were excluded. Furthermore, there is limited discussion on how exploitation rates were included for areas and times with no effort estimates. The paper should be clearer on which data were excluded, included, and how they were included.

CONCLUSIONS

The committee's consensus was that the paper was a beneficial start at documenting and reviewing the IFR Coho MPFT model. However, there were still important components that needed further work to accept the paper and that a subsequent process would review a modified version of the working paper. Furthermore, an editorial panel would provide more ongoing feedback to the authors on improvements to the paper prior to the review process.

- Model is appropriate if limited to use as a fisheries planning tool under defined conditions.
- More work is required related to sensitivity analysis and identifying model assumptions.
- The general conditions within which the model is appropriate needs to be characterized.
- The authors should limit predictions to conditions appropriate to the model only.
- The reference to estimated exploitation rates, identified in item 1 of the TOR, is beyond the scope of this paper and should be reworded as 'projected exploitation rates'.
- The estimates of hatchery exploitation rates, identified as a component of item 2 in the TOR were agreed to be outside the scope of this paper.

RECOMMENDATIONS

- Update the TOR to reflect the predicted nature of the Exploitation Rates and remove reference hatchery exploitation rates.
- Through an editorial panel, further develop the paper for a future CSAS reviewed in conjunction with the Fraser River Coho Decay Model review.

- An editorial panel will provide direct feedback before a subsequent CSAS review: Jeffrey Lemieux (Chair), Jeff Grout (RSIA submitter), Mike Staley, William Gazey, Arlene Tompkins, Elinor McGrath, and Gerry Kristianson.
- Future work in DNA stock identification may better inform the use of this model.
- A future review on release mortality rates will inform the future use of this model.

REVIEWS - EVALUATION OF MARINE RECREATIONAL COHO MARK-SELECTIVE FISHERIES

Working Paper: Evaluation of Marine Recreational Coho Mark-Selective Fisheries - WP2013SAL005b

Rapporteur: Nicholas Komick and Mary Thiess

Presenter(s): David O'Brien

PRESENTATION OF WORKING PAPER

The working paper was presented by David O'Brien and began with background about Mark Selective Fisheries (MSF). The major objective of MSF was to provide fishing opportunities while protecting wild stocks. This requires mass marking to provide a higher mark rate within the fishery than the release mortality rate. The use of MSF regulation impacts the use of indicator stock assumptions and requires more complex assessment.

Following the review of the MSF background, the basic structure of a Double Index Tagging (DIT) study, in the context of the odds ratio method used in this paper, was described. The configuration of a DIT pair study was reviewed and expected MSF impacts on the study were identified.

The presentation concluded with summary results showing DIT odds ratios from the working paper. Based on results from the working paper, the presentation noted that overall hatchery Coho production is marked at levels that support MSFs. Results of the DIT studies suggest that unmarked Coho Exploitation Rates (ER) were approximately 70% lower than marked Coho ER, though this estimate was not statistically significant using parametric statistics. However, fishery specific assessment of MSF impacts is not possible due to the small number of DIT studies and the lack of DIT sampling in particular fisheries.

WRITTEN REVIEWS

Mike Hawkshaw

The first review focused on matching the objectives, as presented in the Terms of Reference, to those addressed in the paper. A summary of the major points identified by this reviewer are provided below (for full review see Appendix B):

There is a variety of alternative analysis methods provided in the various references within the working paper. It is unclear why those other analysis methods were not used. The paper would be strengthened by a review of these methods and identification of data that would be needed to carry out those analyses.

Additionally, a run timing or run reconstruction model may help choose representative DIT indicator streams for various fishery/stock combinations and would possibly help address several of the missing pieces. For example, current DIT hatchery stocks are not reflective of

IFR Coho ocean distribution and migration through fishing areas, making it difficult to link DIT odds ratios to that stock.

Ron Kadowaki

The second reviewer, Ron Kadowaki, highlighted some issues with how the background and application of MSFs in Canada are described in the paper. Also, an alternative analysis approach with the DIT odds ratio was provided. A summary of the major points identified by this reviewer are provided below (for full review see Appendix B).

- Further work is required in order to correctly characterize the Canadian context of MSF programs.
- DIT odds data directly sampled within the escapement environment are the higher quality data, so negative hatchery ER rates suggest issues with other components of the calculation.
- There are scale issues with the analysis and it is unclear if there is a benefit with MSF to recreational anglers.

GENERAL DISCUSSION

The following section summarizes the general discussion that occurred subsequent to the formal reviewers' presentation. Below are the summary points for the discussion. These points are followed by a more detailed description of these major points.

- There are two distinct purposes of MSFs in Canadian fisheries.
- Regulation complexity and inconsistent CWT sampling of unmarked Coho make it difficult to assess fishery-specific impacts.
- A limited number of DIT studies coast wide limit the analytical ability to assess MSFs.
- A lack of DIT studies on IFR Coho limits the analytical ability to assess MSF impact on IFR Coho.
- Concerns with marked and unmarked ER analysis provided in Ron Kadowaki review were noted.
- A possible sampling bias exists, related to DIT CWT sampling with wands.
- There may be adverse impacts to the CWT program with the use of a MSF.

During the discussion, MSFs were identified to have two distinct uses in the context of Canadian fisheries. The first is to allow retention of marked Coho in a Chinook-targeted fishery. Conservation impacts are similar to a non-retention fishery with no additional impact expected on wild Coho stocks. This regulation has the benefit of allowing fishers to retain marked (hatchery-produced) fish, while releasing wild, unmarked fish and therefore maintaining an existing conservation strategy. In this context, the Terms of Reference's identification of Hoffman and Pattillo (2007) and associated application of MSF in United States fisheries may not be applicable to this working paper.

The second use of an MSF is in a terminal fishery where marked Coho are targeted. This use is more in line with the application of MSFs in the United States (e.g. Washington State) and as discussed in Hoffman and Pattillo (2007). In this situation the ratio of mark rates to release mortality rates becomes important to assessing the impacts of the fishery on wild Coho.

In addition to covering these two different uses of MSF in Canada, discussion identified that the working paper introduction should expand on the background of MSF, how it fits within existing policies (e.g. Wild Salmon Policy), and key player relationships. The background should include reasons for enacting an MSF in Canada and important documents supporting its implementation. This background should identify key players in selecting this management strategy and the relationships between the Salmonid Enhancement Program (SEP), fish management, and stock assessment within an MSF context.

The discussion in the working paper about targeting Coho in recreational fisheries seems to have limited benefit to looking at Coho-targeted effort because it is always mixed in recreational fisheries. The committee identified that it would be more relevant to assess the data relation to pre- and post-MSF implementation. The inclusion of data before the Coho crisis may not be appropriate in this circumstance. It may be more appropriate to look at the effect of retention/non-retention of Coho on effort and relative abundance to other species within a specific area and time. However, it was noted that isolating the effect of regulatory differences may be difficult.

Sampling bias was discussed, with respect to adipose-clip status, in escapement CWT sampling using wands. It was identified that more effort may be put into detecting CWTs in marked fish than in unmarked fish. As the wands are potentially sensitive to how they are handled during detection, there is the potential for CWTs to be missed while sampling a fish. More effort may be applied to sampling CWTs in adipose clipped fish as they more frequently carry a CWT than the more rare case of one in an unclipped fish. It was identified that Inch Creek Hatchery is the only place were wands are used for dead pitch sampling. The final suggestion was to add some language to the paper about potential issues with DIT sampling using wands.

When assessing the relationship between MSF regulations and their impacts to particular fisheries, it was reiterated by the authors that the regulatory complexity makes monitoring catch, effort, and ultimately estimating exploitation rates difficult. Numerous issues were highlighted, including the complexity of regulations and coordinating fisheries data (such as 'catch' in the Fishery Operations System (FOS)) to the regulatory dynamics of the fishery.

In addition to the regulatory complexity, gaps in sampling of unmarked CWT Coho further complicate DIT analysis to assess MSFs. For example, the lack of electronic sampling of CWTs in recreational fisheries limits the ability to analyse DIT studies and the impact of recreational MSF. Furthermore, MSF constrains the use of CWT studies on wild indicator stocks, limiting the use of CWT studies beyond hatchery fish. The introduction of the paper should carry some of the adverse impacts of MSF on the use of CWT studies on hatchery fish to represent wild populations.

In the analysis of the paper, it was noted that fry data should be excluded. These data are not directly comparable to the smolt data. The paper should be updated to exclude these data and a corresponding note made with the paper related to this. These two release stages are difficult to directly combine and should be handled separately in the paper.

Upon reviewing Appendix 1 of the paper, the intent of the listed regulations was unclear. The committee agreed that the appendix would be strengthened with information about the reason for establishing each MSF regulation. It may be difficult to provide specific intent of each regulation, but it would be informative to give the general intent for a summarized set of regulations with annual patterns and rationale.

CONCLUSIONS

The committee's consensus was that the paper should be accepted with revisions. Even though the analysis had limitations related to lack of data, particularly with regard to mapping catch and mark rates to individual fishery regulation, it provided relevant information in relation to the use of MSFs in Canada. Some key components of the paper were identified as needing revision and that these changes would be overseen by an editorial panel before final acceptance. A summary of conclusions from the committee are provided below.

- A summary background regarding the two different purposes of MSF regulations in a Canadian context is needed in the paper.
- Relevant comparison with other jurisdictions, as identified in the TOR item 7, may only be partially relevant for Canadian MSF fisheries.
- CWT sampling with wands may be problematic, particularly within a DIT study.
- Complexity and scale of regulations make it difficult to assess and enforce MSFs.
- An editorial panel will provide direct feedback on MSF background and document management measures covered by Appendix 1: Wilf Luedke, Ron Kadowaki, Gerry Kristianson, Richard Bailey, Michelle Walsh.

RECOMMENDATIONS & ADVICE

- Based on hierarchical Bayesian Coho return-year analysis, MSF have a 12% survival benefit with a 70% probability that there is a survival benefit to unmarked Coho based on DIT studies.
- Confidence intervals associated with the DIT analysis is applicable to catch rates under which the data was gathered. Higher catch rates may be associated with increased management risk.
- Release mortality rates are an important piece of estimating effects of MSF. A future review process on release mortality rates would benefit the assessment of MSFs.
- The limited number of DIT studies increase the uncertainty related to MSF assessment. The inability to directly assess IFR Coho using a DIT study is a major barrier to assess the impacts of MSF on that particular stock.
- MSF stock-related data do not necessarily match fishery regulation data, because stock and regulation areas may not be spatially congruent in some cases. This causes a large source of uncertainty in the present analyses and needs to be recognized and addressed in the design of future data collection.

ACKNOWLEDGEMENTS

The Chair thanks the reviewers for their expertise in reviewing the working paper, and all of the participants for their constructive engagement in the science review process at this meeting. Nicholas Komick is thanked for being a rapporteur. Lesley MacDougall's and Ann Mariscak's assistance in providing CSAS meeting support is greatly appreciated.

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APPENDIX A: TERMS OF REFERENCE

Evaluation of Marine Recreational Coho Mark Selective Fisheries in British Columbia, including an evaluation of the Canadian marine fishery exploitation model for Interior Fraser Coho

Regional Peer Review Process – Pacific Region

March 3-5, 2015
Nanaimo, British Columbia

Chairperson: Jeffrey Lemieux

Context

Declines in the abundance of southern British Columbia Coho Salmon populations, in particular Interior Fraser River Coho (IFR) Salmon, through the 1990's, resulted in harvest restrictions for Coho Salmon in all sectors beginning in 1998. Following the initial harvest restrictions, fisheries management measures were implemented that would allow for some fishing while addressing the need to protect IFR and other wild Coho Salmon stocks.

In 1999, a pilot Coho mark-selective fisheries (MSF) program was implemented in select areas, allowing the harvest of marked (adipose fin clipped) hatchery produced Coho with release of wild, non-marked, fish. Over about five years, Coho MSF were expanded to include all southern British Columbia (BC) recreational salmon fisheries with non-retention of wild Coho, as well as the West Coast Vancouver Island (WCVI) troll fishery at some times of year (e.g., September).

These MSF were implemented under a domestic operational target exploitation rate (ER) ceiling for IFR Coho Salmon of 3%. This management objective was in place through 2013. In 2014, after a review of IFR Coho Management Unit status relative to recovery objectives (DFO 2014), the ER objective was adjusted to permit impacts up to 16% in Canadian domestic fisheries. Currently, Canadian marine exploitation rates are forecasted and estimated for IFR Coho using a model based on the relationship between effort and measured exploitation in the 1987 – 1997 base period. IFR Coho fresh water fishery impacts in the Fraser River are estimated using a separate model which is not included in this review. Neither model has been evaluated or peer reviewed.

The Coho MSF and the associated ER estimation approaches have not been evaluated. Fisheries Management and the Salmon Enhancement Program have requested that Science Branch conduct a review of both the IFR Coho ER models and the Coho MSF program to evaluate their effectiveness and utility as management tools.

This Canadian Science Advisory Secretariat (CSAS) Regional Peer Review (RPR) will address the marine aspects of the request, evaluating the marine ER modelling for IFR Coho and the effect of the MSF on marine fisheries. The assessment will include the compilation, analysis and reporting of data collected through the Recreational Creel, Mark Recovery, escapement monitoring, Salmon Enhancement and other MSF survey programs, focusing on key catch and effort metrics, before and after the implementation of IFR Coho conservation measures.

An evaluation of the freshwater IFR Coho ER model and the effect of the MSF on catch, effort and estimated exploitation rates in the freshwater fisheries will be conducted in a separate RPR, and together with this review, will facilitate the overall evaluation of the MSF to meet the stated objectives for this program.

It is recognized that there are several confounding factors and uncertainties, such as the changes in the abundance and distribution of Coho and other species of salmon that would

have influenced directed and non-directed fishing behaviour of the recreational sector. As a result, drawing conclusions about responses in recreational fishing effort as a result of MSF regulations, for example, will be challenging and may only allow for qualitative conclusions

This assessment, and advice arising from this Canadian Science Advisory Secretariat (CSAS) Regional Peer Review (RPR), will be used to inform the overall evaluation of the MSF program, the development of Integrated Fisheries Management Plans (IFMPs) for southern BC salmon and future production and marking strategies of the Salmonid Enhancement Program.

Objectives

The objectives of this RPR are to: a) describe and document methods, evaluate the implications of the assumptions and base-period data used to parameterize the marine IFR ER model, report uncertainties and limitations in modeling and estimate IFR Coho ER for recreational and commercial marine fisheries; and, b) examine the effect of the MSF on catch, effort and estimated exploitation rates in the marine fisheries from 1998 through 2014.

The following two working papers will be reviewed to provide the basis for discussion and advice to address the two objectives stated above. Specific for each working paper, the following outputs are to be reviewed:

Interior Fraser River Coho Exploitation Rate Estimation Methods. CSAP Working Paper 2013SAL005a

1. Document the methods used to estimate exploitation rate (ER) for IFR Coho for marine fisheries in Canadian waters south of Cape Caution, including the base period data and assumptions required to parameterize the model, and implications of those data and assumptions on estimated ER's.
2. Update estimates of the total exploitation rate on IFR Coho in all marine fisheries in Canadian waters south of Cape Caution, as well as the exploitation rate on hatchery produced Coho Salmon by the marine recreational fishery, up to and including 2014.
3. Describe the sources of uncertainty related to the model (e.g., inside – outside distribution, change in fishery patterns, fisher behaviour, changes in gear, etc.), based on sensitivity analysis where possible.

Evaluation of Marine Recreational Coho Mark Selective Fisheries. CSAP Working Paper 2013SAL005b

4. Document the objectives of the MSF and the management measures undertaken to implement IFR Coho conservation starting in 1998 through 2014, with a focus on recreational marine fisheries in Canadian waters south of Cape Caution.
5. Compile, analyze and report on recreational catch and effort metrics, Coded Wire Tag (CWT) data, salmon enhancement and marking programs relevant to the assessment of the MSF objectives. Data prior to (pre 1998) and during the implementation of MSF, up to 2014, should be considered.
6. Assess the effect of the MSF on catch, effort and estimated exploitation rates in the marine recreational fishery from 1998 through 2014. Include commercial.
7. Provide a summary of MSF evaluations conducted in other jurisdictions (e.g. Washington State: *Hoffman & Pattillo 2007*) and consider relevant comparisons with this assessment.
8. Consider the limitations, confounding factors and uncertainty in the results of this evaluation, including but not limited to the monitoring programs, assessment programs, and compliance with regulations.

Expected Publications

- CSAS Science Advisory Report
- CSAS Proceedings Document
- CSAS Research Document (2)

Participation

- Fisheries and Oceans Canada (DFO) (Science, Fisheries Management, and Salmonid Enhancement Program)
- First Nations
- Commercial and Recreational Fishing Representatives
- Environmental Non-government Organizations
- Academia

References

DFO. 2014. Assessment of the Interior Fraser River Coho Salmon Management Unit. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/032

A. Hoffman & P.L. Pattillo. 2007. The Practical Application of Mark-Selective Fisheries. American Fisheries Society Symposium 49: 587 – 595.

APPENDIX B: WORKING PAPER REVIEWS

REVIEWER: WILLIAM J. GAZEY

W.J. Gazey Research

Date: February 26, 2015

CSAS Working Paper: 2013SAL005a

Working Paper Title: "*Interior Fraser River Coho Marine Fishery Planning Model and Updated Exploitation Rates*" by P.V. Van Will, W. Leudke and D. Dobson

The purpose of the working paper is clearly stated and is aligned to the Terms of Reference for this CSAS Review. The model structure was restricted to a single driver stock (Interior Fraser River, IFR) with catch taken in fisheries not directed at Coho salmon, i.e., bycatch. Under these restrictions the data and methods (model) were adequate to support the results and model performance. Due to poor organization of the paper and lack of text clarity (the paper requires the attention of a copy editor), the paper required several readings to comprehend. However, the paper did generally provide sufficient detail to evaluate the results and conclusions. Details not provided were the input data used for the 2014 exploitation rate estimates. Such detail may provide more insight on how the model is used as a planning tool. The only explicit recommendation, aside from the running the model for planning and managing fisheries, was to review the release mortality rates for each fishery. While the authors make a good case, the call for more study of release mortality has been a perennial appeal during my 40 year history with fisheries science. I am skeptical a comprehensive study will happen soon. I suggest that sensitivity analysis be conducted using continuous parametric distributions (e.g., normal, lognormal) with various mean and standard deviation parameters instead of the sparse discrete distributions found in Appendix 7.

Other important comments follow:

1. The paper would be easier to read with a standard Introduction-Methods-Results-Discussion format. Sections 2 and 3 could be placed under Methods. Note that the current header "3.1 EFFORT" is redundant.
2. Justify early in the Introduction the need for a planning tool that focuses just on the IFR stock and why the model must operate without estimates of Coho abundance.
3. There are frequent mentions in the text that estimates are an update of an existing model that are confusing. Is the old model documented? The only associated citation seems to be Decker et al. (2014) used on page 14 on the Results. If the Decker documentation is adequate then build the methodology on it (I assume the new fisheries and stochastic addendums). If the document is not adequate then provide the history and credit of development in the Introduction then detail a full standalone version in Methods.
4. The placement of the methodology to deal with new fisheries not in the base period at the end of the "Data Sources and Model Inputs" section is confusing. Put all the model development together.
5. The equations would be more readable with a simplified notation and then the equations could be combined. For example, equations (2) through (5) can be replaced with:

$$ER_{im} = u_m \cdot E_{im} \cdot F_T \cdot \left[F_B + (1 - F_B)F_M\right]$$

where, ER_{tm} is the estimated exploitation rate, u_m is the mean base ER to be applied for the fishery, E_{tm} is the relative effort, F_T is the target scalar, F_B is the bag limit scalar (set to 0 for non-recreational fisheries) and F_M is the release mortality scalar. The WCVI offshore recreational fishery (equation 9) would also fit the above format. Similarly, the Gulf of Georgia purse seine fishery (equations 6 through 8) could be reduced to a single equation.

6. Add a Discussion section. Some of the material discussed in the Model Overview, particularly under assumptions and limitations, would be better placed in a Discussion section. The assumptions should be stated and explained in Methods. The assumptions should be revisited in Discussion with respect to the likelihood of the assumption holding and the authors' opinion on the impact from assumption failure. The sensitivity analysis should be discussed with respect to impacts on management of the fishery. For example, could release mortality uncertainty lead to credible concerns for the effectiveness of mark selective fisheries. Another topic that requires discussion are the conditions under which the model is not appropriate; namely, other stocks that may require conservation efforts or Coho abundance recovers to the extent that directed fisheries are possible or recreational fishers would switch effort from other species to Coho.

REVIEWER: MICHAEL STALEY

IAS Ltd

Date: February 26, 2015

CSAS Working Paper: 2014SAL005a

Working Paper Title: "Interior Fraser River Coho Marine Fishery Planning Model and Updated Exploitation Rates" by Pieter Van Will, Wilf Luedke, and Diana Dobson

RPR Objectives

The objectives of this RPR are to:

a) describe and document methods, evaluate the implications of the assumptions and base-period data used to parameterize the marine IFR ER model, report uncertainties and limitations in modeling and estimate IFR Coho ER for recreational and commercial marine fisheries; and,

b) examine the effect of the MSF on catch, effort and estimated exploitation rates in the marine fisheries from 1998 through 2014

In addition to:

1. Document the methods used to estimate exploitation rate (ER) for IFR Coho for marine fisheries in Canadian waters south of Cape Caution, including the base period data and assumptions required to parameterize the model, and implications of those data and assumptions on estimated ERs.
2. Update estimates of the total exploitation rate on IFR Coho in all marine fisheries in Canadian waters south of Cape Caution up to and including 2014.
3. Describe the sources of uncertainty related to the model (e.g. historic variability in ER, effect of inside – outside distribution, change in fishery patterns, fisher behaviour, changes in gear, etc.), based on sensitivity analysis where possible.

General Comments

The paper refers to the analysis presented as a "Fisheries Planning Tool". The objectives also asked for "estimates" of exploitation rates. Planning (forecasting) and estimating (assessing) should be viewed as two quite different processes. Fisheries planning, often by necessity, is based upon many assumptions about the expected or forecast behavior the fish, the fishery and their environment. Estimating resulting exploitation rates is an assessment role ideally involving the measurements of results of the planned actions. Assessments should include at least some measurements that are independent of the data and assumptions used to forecast or plan. The use of planning tool with all of its assumptions to both forecast and then "estimate" the realized exploitation rate is at best circular if not self-serving. Assessing the performance of the fisheries using the planning tool with no independent verification is akin two confirming that 2+2 indeed does equal 4. An assessment or "estimate" of the realized exploitation requires independent data from those that were used to forecast the performance of and plan the fisheries.

It is my understanding that there were DNA samples taken in most of the Marine fisheries in 2014. That these will be used to try to "ground truth" the forecast exploitation rates. These data may be very useful to assess the ability of this planning tool as an indicator of realized exploitation rates.

Specific Comments

In the Introduction on page 1 it would be helpful to have more clarity on the word "prevalent". From table 7, the pooled CWT recoveries, the average exploitation rate of the base period was 2.9% for the northern troll and .48% for the northern sport or recreational fishery. These exploitation rates are higher than some of the fisheries in the south coast that were included in the analysis such as Johnstone Straits net and the West Coast Vancouver island sport fishery during the base period. Terms of reference call for analysis fisheries south of Cape Caution, there appears to be significant and measurable exploitation in the North coast, there needs to be some further discussion of the rationale for excluding northern fisheries from the analysis and the management actions.

Coho FRAM

This section promises a comparison of FRAM predictions with MFPT predictions in the results section. The results section comments that FRAM "predictions are similar and a bit higher" hardly qualifies as "documentation". Tables and/or graphs comparing some of the outputs would be helpful.

Model Overview

Stocks:

It appears true that this is a single stock model: IFC. However, there are two stock groups used in the "Target Scalars": Coho and all other salmon.

Fisheries:

Decisions on what fisheries to include in the model seem to be based upon the concept of "prevalent". This section also refers to the number of "observed" CWT in the fishing area. While table 7 presents the expanded or estimated number of tags in the fishery and spawning escapement, it does not present "observed" number of tags. Presentation of the actual number of observed tags would be helpful to gain perspective on number of real observations that form the basis of the analysis.

Time Step:

This model does not have a time step. It stratifies the data and the analyses by year, month and fishery but does not step through time.

Assumptions and limitations:

The objectives in the terms of reference for this paper not only call for documentation of assumptions:

"Document the ... including the base period data and assumptions required to parameterize the model, and implications of those data and assumptions on estimated ER's";

But also the evaluation of the implications of the assumptions:

"... evaluate the implications of the assumptions".

This section on assumptions and limitations goes partway through documenting some of the assumptions, but in the main fails to evaluate the implications of those assumptions to the results of the model and/or to the results of management of the stocks and fisheries.

CWT fish accurately represent the wild IFR Coho:

This section identifies problems with low numbers of recoveries in some time – area strata. However it doesn't evaluate implications of low numbers of recoveries. In fact the numbers of recoveries are not presented in the paper so the reader can appreciate the implications of low numbers of CWT recoveries. The section also asserts both the escapements and historical fisheries were "well sampled for CWT's" without documentation or directing the reader to specific references and locations.

There is no evaluation of the implications of assumptions used to calculate estimates of exploitation rates from CWT recoveries on the exploitation rates used in this paper. Statistical properties of the estimated CWT expansions from samples are reasonably well understood and behaved and should be included in the evaluation of these assumptions as well as the sensitivity of the resulting exploitation rate estimates.

Effort is proportional to exploitation rate:

While there is some presentation of the relationship between exploitation rate and effort from various years within a month-fishery strata (figure 2 in the paper) there is no evaluation of alternative models to the proportional model. Exploitation rate/effort relationships may be curvilinear. It is very likely that the shape will have a significant bearing on the performance of this model.

Furthermore there is no documentation of the relationship used; no correlation or statistical evaluation of any significant relationship between effort and exploitation rate. A basic part of the documenting this model is to confirm or reject the significant statistical relationship of ER to effort. This relationship is pivotal to this paper and requires evaluation.

Stock distribution and migration is constant:

It is most unlikely that stock distributions and migrations are constant. Other species of salmon display significant changes in distribution, migration routes and timing (i.e. sockeye salmon). While this section may identify potential hypotheses; they are not articulated to allow evaluation. Sensitivity analysis called for in this paper should evaluate the implications of a variety of changes in distribution and migration routes, rates and timing. This has not been done.

There are also assumptions about mortality between fisheries and in between fisheries and the spawning grounds. We now understand for other salmon species in the Fraser, such as

sockeye, there can be large and variable on route mortality between fisheries and the spawning grounds some of which may be stock specific. This section provides no documentation and there are no evaluations of the implications assumptions such as on route mortality.

There are not multiple encounters with gear:

The paper asserts without foundation that "fish were caught only once" in the base period. This section merely states the assumption. There are no documents are references used to substantiate this assumption. Furthermore there is no evaluation of the implications of this assumption as may be contrasted to an alternative.

Fisheries have changed from the base period:

This section is a brief overview of possible changes fisheries. Does not document all of the potential and known changes such as introduction of electronic computing devices, enhance location and navigation (such as GPS) for fishers; vessel technology both commercial and recreational in terms of speed, reliability or seaworthiness. There are many changes to the fishery could result in changes the 'catchability' coefficient. Changes in the coefficient would have direct impacts on the projected exploitation rates. So this section is a limited documentation with no evaluation of alternative assumptions of changes in fishing methods patterns or efficiency.

Management actions in a fishery do not affect a subsequent fishery along the migration path:

This may be a reasonable assumption during periods of very low exploitation. But should be considered when comparing and using exploitation rates derived from high exploitation periods such as the base period to project low exploitation rate forecasts recently. Also if and when increased exploitation is warranted for IFC increased exploitation in one fishery may have implications for the protections on other fisheries. The approach to this assumption stated was not evaluated in itself or in comparison to or insensitivity with of other assumptions.

Last paragraph of the assumption section refers to "results of validation exercises (such as DNA stock composition)" there is no reference to the description of or documentation any such exercises.

General Model Structure

This section provides the linear equations that describe the calculations in the model. It does not fully document the model nor evaluate the assumptions embedded in these equations. At a minimum there should be some discussion about alternative equations, such as nonlinear ones. Evaluation would be related to risks if alternative forms of these equations were tested.

In other recent CSAS reviews of fisheries models the computer code with internal documentation has been included in the paper. It would allow peer reviewers to do their due diligence and replicate the results. The code or worksheets have not been provided to the reviewers.

New IFR Coho Marine Fishery Planning Tool underlying model

I have no capacity to review Microsoft Excel Crystal Ball implementation of this simulation model. It is unfortunate that effort was not made to migrate these calculations to R. R has become the most used modeling environment for fisheries particularly at the Pacific Biological Station and the Pacific salmon commission.

Crystal Ball has a sticker price of approximately $1000 US. While R and many of the simulation packages, suitable to this kind of work, are free and available. As a reviewer I can't replicate these calculations in this framework.

Data Sources and Model Inputs

The statement about the marine First Nation's fisheries and marine test fishery exploitation rate being fixed without documentation is not adequate. There must be some documentation of the source of these numbers. Furthermore evaluation of alternatives models for these fisheries is essential to evaluating the assumptions.

For commercial effort, catch and exploitation rate data tables there are no tables for Juan de Fuca gillnet. There are tables for Johnstone Strait gillnet but not Juan de Fuca. For the effort and catch data for both commercial and recreational there are no data in the tables for 2014. But there are updated model outputs of exploitation rate for 2014.

Base period exploitation ra.es

When reviewing the tables I found some anomalies in the base years exploitation rates. In the recreational fishing data there are many cases of year-month strata that have exploitation rate estimates for which the catch and effort strata are blank. In most cases the exploitation rate is zero however zeros are included in the average exploitation rate over the base years for that month and may bias the average or years for that month if there were no fisheries with a zero estimated exploitation rate. There are some cases where positive exploitation rates exist for strata that have blank effort and catch data. (See tables at end of this review).

There were also differences in the average exploitation rate for fisheries calculated from the data in table 7: totaled across months; of the average across years as compared to months across years in most fisheries. This may be due to differences in over months then summing over years as opposed to the aggregate of the year. But there should be some discussion and treatment of these differences; while small, they may be significant, particularly where the exploitation rate is low.

In the data review and preparation section there should be some discussion on the quality of the old sales slip data: 1987 to 1995. Also should be some references to quality assurance programs on the FOS system as part of the documentation.

Incorporating historic variation into ER estimates:

The approach to modeling variation in simulation models can have a profound impact on the performance of the model. Exploitation rates do vary considerably year to year across this month/fishery strata. Sampling only from the existing data (realizations of the underlying distribution) may understate variability. A properly constructed posterior distribution pf ER's based upon the 10 years (many cases less than 10) of samples would likely be wider and more diffuse than the discrete bins represented by the realizations in the historical data.

There should be some attempt characterize and model the distribution of exploitation rate then incorporate that distribution in simulations. This is where a programming framework such as R and its associated Bayesian packages would be more convenient on the Crystal Ball framework.

In addition to the errors and variations in the catch and effort data observed elsewhere in the report, the small numbers of recoveries, in some cases the small catch sampling rates and tagging rates, suggest that the inherent variation in the CWT recovery data, as a result of sampling and expansion, must be included.

Release mortality scalar

In this section there are several references to studies but no references to documentation of these studies. The simulation model should include not only the variation between the point estimates of the studies but also variability in the results of each of the studies.

The area of release mortality studies is advancing rapidly with the work being done at UBC, Carleton University and the University of Victoria. The model should be capable of adapting to these new studies.

Catchability: Target Scalars

This section presents one model for describing changes in 'catchability' due to changes in target species. There is no foundation for ratio of catch is an indicator of relative target 'catchability.' The model presented here is only one such model and there is no evaluation of the implications of the assumptions embedded in.

Recreational Daily "Bag" limit scalars

Are there scalars for WCVI?

How is recall bias accounted for?

Is there information for the 2014 Creel, given partial retention, to help verify these assumptions?

Choosing years to include from the base period

While "Understanding the distribution of Coho populations being modeled to determine exploitation is extremely important," It was not used in the base years because they "encompassed" the "average" distribution and the recent years because they reflect the base years. Is this appropriate for a planning tool that is used to predict each year then used again to assess the performance of those predictions?

Model Results

With the small number of samples for ER and release mortality the simulation does not explore the full extent of the distribution of these variables. The simulations should draw from distributions that reflects the samples but encompasses the full range of the underlying distribution.

Sensitivity analysis

Another major source of uncertainty not included in the model is the variation due to CWT sampling both application (including representative) and recovery that also involves uncertainty and variation in catch estimates.

Model Performance

The l ck of independent information to assess the model performance is extremely important. The fishery management actions taken in the late 1990's to address IFC conservation were singularly the most dramatic shift in management in recent times. The actions had and have far reaching impacts to almost every salmon fishery on the south coast and in the Fraser River. Given the extent and degree of impacts on fisheries of these management actions, and the communities that rely on them, it should be a high priority to be able to assess the performance of the models and analyses that are used for planning and assessing these fisheries.

The authors conclude that:

"Overall the performance of the model appears to be sufficient for planning and managing fisheries with low impacts due to low effort levels relative to the base period."

This depends upon the objectives of management. If the objective of fisheries management was only to deal with the population biology of the stocks for the purpose of maintaining low levels of catches this model and analysis may be sufficient.

Fisheries management includes more that fish population levels and catch. After conservation there are priorities of distribution of access to and harvest of the resource that must be managed. The management of the distribution of access and catch has many legal and policy implications. This model is not sufficient for planning and managing these other important aspects of fisheries.

Tables that indicate year-month-fishery stratum where an ER is not blank in the tables from Appendix 5 for which the corresponding stratum is blank for catch and effort in Appendixes 1 through 4.

Georgia Strait North Recreational Base Period

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1987	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-		-	-		
1990	0.24%	0.00%	-	-	-	-	-	-	-	-	-	-
1991	-	-	0.00%	-	-	-	-	-	-	-	-	-
1992	-	0.00%	-	-	-	-	-	-	-	-	-	-
1993	0.00%	0.51%	-	-	-	-	-	-	-	0.00%	0.00%	-
1994	-	-	0.00%	-	-	-	-	-	-	-	0.00%	-
1995	-	-	-	-	-	-	-	-	-	-	0.00%	-
1996	-	-	-	-	-	-	-	-	-	0.00%	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-

Georgia Strait South Recreational Base Period

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1987	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-
1990	0.00%	-	-	-	-	-	-	-	-	-	0.00%	-
1991	-	-	-	-	-	-	-	-	-	-	-	0.00%
1992	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	0.00%	-	-
1994	-	0.00%	0.00%	-	-	-	-	-	-	-	0.00%	-
1995	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	0.00%	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	

Juan de Fuca Recreational Base Period

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1987	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-
1990	0.00%	0.20%	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	0.00%	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	0.00%	-	-
1994	0.00%	-	-	-	-	-	-	-	-	-	-	-

Juan de Fuca Recreational Base Period												
1995	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	0.54%	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-

WCVI Recreational Base Period												
Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1987	-	-	-	-	0.00%	-	-	-	-	-	-	-
1988	-	-	-	-	0.00%	0.00%	0.24%	-	-	-	-	-
1989	-	-	-	-	0.00%	0.24%		-	-	-	-	-
1990	-	-	-	-	0.00%	0.47%	-	-	-	-	-	-
1991	-	-	-	-	0.00%	0.45%	-	-	-	-	-	-
1992	-	-	-	-	0.67%	1.34%	-	-	-	-	-	-
1993	-	-	-	-	0.00%	0.00%	-	-	-	-	-	-
1994	-	-	-	-	-	0.00%	-	-	-	-	-	-
1995	-	-	-	-	0.45%	-	-	-	-	-	-	-
1996	-	-	-	-	0.00%	-	-	-	-	-	-	-
1997	-	-	-	-	0.00%	-	-	-	-	-	-	-

Johnstone Strait Recreational Base Period												
Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1987	-	-	-	-	0.00%	0.00%	0.00%	0.11%	-	-	-	-
1988	-	-	-	-	0.00%	0.25%	0.21%	0.00%	-	-	-	-
1989	-	-	-	-	0.00%	0.00%	0.25%	0.00%	-	-	-	-
1990	-	-	-	-		0.00%	0.45%	0.15%	-	-	-	-
1991	-	-	-	-	0.34%	0.34%	-	-	-	-	-	-
1992	-	-	-	-	0.05%	-	-	-	-	-	-	-
1993	-	-	-	-	0.00%	-	-	-	-	-	-	-
1994	-	-	-	-	-	1.22%	2.15%	0.00%	-	-	-	-
1995	-	-	-	-	-	0.00%	0.12%	0.00%	-	-	-	-
1996	-	-	-	-	-	0.00%	0.00%	0.00%	-	-	-	-
1997	-	-	-	-	-	0.00%	0.00%	0.00%	-	-	-	-

TJohnstone Strait Commercial Salmon Troll Base Period												
Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1987	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	0.00%					
1996	-	-	-	-	-	-	0.00%	-	0.00%	-	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-

Strait of Georgia Commercial Salmon Troll Base Period												
Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1987	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	0.00%	0.00%	-	-	-	-

Johnstone Strait Commercial Purse Seine Base Period												
Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1987	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	0.00%	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-

REVIEWER: MIKE HAWKSHAW

Fisheries Center at UBC

Date: 25 February 2015

CSAS Working Paper: 2014SAL005b

Working Paper Title: "*Evaluation of Marine Recreational Coho Mark-Selective Fisheries*" by D.S. O'Brien, K. Hein, J. Sawada and W. Luedke

Summary

The central goal of this paper as I understand it is to try to quantify the effects of the MSF fishery on wild stocks especially IFR Coho. The terms of reference state:

"[Objective for other paper]; ***and, (b) examine the effect of the MSF on catch, effort, and estimated exploitation rates in the marine fisheries from 1998 through 2014"***

The authors do a credible job of addressing many of the specific points called for in the terms of reference, presenting the catch and effort trends, and do some necessary analysis for estimating exploitation rates. I have a concern that there are issues of organization and some additional analysis that need to be addressed in order for the paper to meet its objective.

1) The presentation makes it hard to judge the full effect of MSF on wild Coho stocks.

2) I think that the paper would be strengthened by additional calculations that I detail below

I feel that with some additional work this paper could do a much better job of examining the effect of the MSF on estimation of exploitation rates and the likely impacts of the MSF on wild Coho stocks.

Further suggestions

1. Organization

Compiling and reporting on the data available to evaluate the MSF for Coho salmon is well done. Catch and effort data are presented and the data sources are clear and well described.

The introduction and methods should more clearly address the types of analyses that **could and have been done by other authors**, and then the authors should **do** those that are possible in the results, and explain **why** the others have not been done in detail in the discussion.

The authors should take time in the discussion to more clearly layout the type of data collection programs (additional tagging, test fisheries, sampling, creel sampling, etc.) that would be needed to do any missing calculations.

If I understand correctly the role of the CSAS paper is not to prescribe courses of action for management. Outlining the data collection that is a prerequisite for the full suite of analysis would allow managers to be able to decide how to go about assessing the impacts of MSF in the future without being prescriptive.

2. Supplementary calculations

The reference material (Hoffmann and Patillio 2007, Hoffmann and Alexandersdottir 2004, and SFEC 2002) explore a suite of useful analysis and discuss the data collection needed to address bias and precision. The authors rightly point out that there are two main effects of a MSF that should concern managers and biologists:

- The effect on the information collected in existing coded wire tagging programs because of differential removal of coded wire tagged fish from the population
- The impacts of handling, and cryptic mortality on unmarked fish

There are methods presented in the three reference papers cited above to address these points.

The "estimation method using hatchery release unmarked-to-marked ratio" and "estimation method using hatchery escapement unmarked-to-marked ratio" method from Hoffman and Alexandersdottir(2004) (pg 7), the calculations in Table 3 of Hoffmann and Patillio (2007), and the "Equal Marine Survival (EMS) method" in SFEC (2002) (on page 9) should all be applied, or modified as required. This would provide several estimates the effect of MSF on wild co-migrating stocks and the necessary information to examine the effect of the MSF of CWT programs. If they are not carried out for specific reasons (e.g. lack of data, resources for analysis, or a violation of core assumptions in the methods) then the **reasons for not** doing these types of analysis should be presented along with an indication of what would need to be done to enable these types of analysis if they are deemed necessary at a later time.

Some specific additional measures could be taken in this paper to improve the ability of the reader to estimate the impacts of the MSF on wild stocks regardless of the decision/ability to do the calculations I suggest in the preceding section:

- Show the estimated ratio of unmarked to marked fish vulnerable to the fisheries. I mean don't show the odds ratio for a specific hatchery DIT pair but the estimate of the sum of the unmarked to sum of the marked fish expected to be encountered in the different

fisheries – this should be possible using reconstructed wild and hatchery numbers. This could be a terrible estimate but it seems like a necessary prerequisite when talking about the potential impacts of MSF fisheries on wild/co-migrating stocks.

- The reconstructed numbers in 1 should be contrasted this with the observations you do have on the ratio of marked to unmarked fish in different fisheries.

This paper and the other papers I've read assign great importance to knowing the ratio of marked to unmarked fish vulnerable to fishing. One of the key characteristics of a MSF is that the impact on unmarked fish decreases as the higher the ratio of marked to unmarked fish is in the fishery. I think this estimate should be reported and its importance highlighted in the results or discussion.

- DIT estimates presented should be combined with vulnerability of marked vs unmarked fish and the proportions of wild stocks in the unmarked population to estimate stock specific impacts of the effect MSF

Applying the new calculations might end up showing that the estimates of impacts of MSFs are divergent, they might be inconclusive because of issues with data, or they might all show similar estimates of the impacts of MSFs. These are all reportable findings seem like they would strengthen the paper.

REVIEWER: RON KADOWAKI

Retired DFO biologist/manager

Date: Feb. 23rd, 2015

CSAS Working Paper: 2014SAL005b

Working Paper Title: "*Evaluation of Marine Recreational Coho Mark-Selective Fisheries*" by D.S. O'Brien, K. Hein, J. Sawada and W. Luedke

A definitive evaluation of marine recreational Coho mark-selective fisheries is challenging given the limited amount of reliable data available and the many assumptions that have to be made when analyzing them. The analysis must therefore make the best use of all relevant information and conclusions must be drawn in a logical and transparent manner while clearly indicating where there are potential biases and uncertainties that may affect results. The reviewer also notes that the authors were provided a Terms of Reference with specific objectives (below) for their working paper and will attempt to confine the scope of the review accordingly.

- Document the objectives of the MSF and the management measures undertaken to implement IFR Coho conservation starting in 1998 through 2014, with a focus on recreational marine fisheries in Canadian waters south of Cape Caution.
- Compile, analyze and report on recreational catch and effort metrics, Coded Wire Tag (CWT) data, salmon enhancement and marking programs relevant to the assessment of the MSF objectives. Data prior to (pre 1998) and during the implementation of MSF, up to 2014, should be considered.
- Assess the effect of the MSF on catch, effort and estimated exploitation rates in the marine recreational fishery from 1998 through 2014; include commercial.
- Provide a summary of MSF evaluations conducted in other jurisdictions and consider relevant comparisons with this assessment.

- Consider the limitations, confounding factors and uncertainty in the results of this evaluation, including but not limited to the monitoring programs, assessment programs, and compliance with regulations.

The review will generally follow the topics covered by the working paper and will conclude with a summary of key points.

1. Introduction

a. The first mark-selective fishery (MSF) was piloted in British Columbia in 1998 using the ventral clip as the mass mark, not in 2000 as noted in Section1.3. Adipose clips were used beginning in 1999 (SFEC, 1999).

b. Section 1.1 indicates that the "management objective of MSF's is to allow the retention of marked often hatchery produced fish...". Any mass marking of non-hatchery fish should be noted and explained.

c. The authors note that "*There is little documentation of rationales for management decisions around implementation of Coho MSF's.*" But, they then go on to quote the report of the Coho Response Team (1998) that contains this rationale along with some cautions on potential impacts to assessment data quality. More detail on what might be missing in this documentation to prompt this comment would be helpful.

2. SEP Hatchery Production

a. SEP hatchery releases should be separated into smolt and fry categories to distinguish releases that are directly related to mass marking and MSF's, ie. smolts. Higher marking mortality and lower survival to fisheries makes fry marking much less cost effective than smolt marking in supporting MSF's.

b. Time series of US hatchery releases of marked Coho smolts would be informative with respect to certain MSF fisheries where US fish can make a significant contribution to the mark rate, e.g. JDF sport, SWVI Troll.

c. Hatchery production is mentioned as one of the costs of MSF's (Section 4.1), however, SEP has been in place for a long time prior to MSF's ,and production costs would have continued whether MSF's were instituted or not. Costs of mass marking are another matter, however, and a question going forward might be whether mass marking would be done routinely even if wild Coho stock status improves and MSF's were no longer necessary on a regular basis.

3. Catch, Mark Rates, Species Targeting

a. Given the focus of this analysis on the southern BC recreational fishery, a table of estimated catch should be provided along with Figure 3. Presumably the retained catch from 1998 to 2005 would have been attributable to the MSF's conducted in those years. The magnitude of the marked catch would give some additional perspective on the importance of MSF's to the recreational fishing sector.

b. Comparisons of trends in retained catch (Fig. 4) and fishing effort (Fig. 5) before and after 1998 seem to be confused by the inclusion of WCVI and Johnstone Strait data from 2000 onward and not before. If this is correct, this should be acknowledged in the working paper and inferences about trends should be adjusted accordingly.

c. Appendix 1 indicates that there have been an increasing number of mixed bag limit fisheries throughout the post-1998 period in all regions of south coastal BC. The location and duration of these fisheries appear to be highly variable. The only apparent mention of these fisheries in the working paper is at the end of Discussion Section 4.3,

"Changes to MSF regulations in commercial and recreational fisheries occurred in 2013 and 2014, with unmarked retention either allowed in a mixed-bag MSF, or as non-selective fisheries." There are no descriptions of these fisheries and their potential impact on unmarked fish or on fishing effort patterns in these years or in previous years.

d. Appendix 1 also indicates that the daily bag limit has varied over time and areas, usually at 2 per day but occasionally at 4 per day. The impact of daily bag limits combined with MSF status might also have an effect on angler effort patterns.

e. In Section 2.2.1, the following analysis is described:

"To evaluate the variability in mark rates within and across years, we calculated the interview-based mark rate on a weekly time step by Pacific Fishery Management Area (PFMA) from July to September for all monitored marine recreational fisheries south of Cape Caution."

The results of this analysis are not presented. However, they would most likely be very helpful to fishery managers in identifying PFMA's where mark rates were much higher than specified release mortality rates, making them more suitable for MSF regulations as noted previously.

a. Target-species interview results could be important in evaluating the benefits of the MSF strategy. From the results presented, it appears that <10% of interviewed anglers indicated that Coho was among their targeted species. Another pertinent question might have been whether anglers would have gone fishing that day for other species if the fishery was completely closed to Coho retention. Responses to this question might have allowed for a direct estimate of the incremental benefit of MSF regulations in angler-days of effort. Mixed bag limit regulations might have also caused more anglers to indicate that Coho were among their target species.

b. A brief description of catch monitoring and sampling programs would be informative, especially where methodologies have changed over time. Without this background, it's difficult to determine which pieces of information are based on independently sampled data and which are based on less rigorous methods.

4. Release Mortality

a. The release mortality rate for recreational fisheries has been extensively studied and a rate of 10% appears to be generally accepted and is included in the annual South Coast Salmon Integrated Fisheries Management Plan (IFMP). The estimated mark rate based on angler interviews for all south coast recreational fisheries has averaged 29.1% (range of 20.3% to 39.8%). On average, this appears to satisfy the advice that mark rates be significantly higher than release mortality rates to achieve benefits from MSF's (Hoffman and Patillo, 2007).

b. Release mortality rates for commercial troll fisheries have not been studied as thoroughly but are thought to be higher than for recreational fisheries. A release mortality rate of 26% is specified for commercial troll fisheries in the IFMP. This is similar to the estimated mark rate in MSF openings of 29.2% (range of 18.5% to 39.7%) presented in the working paper. According to Hoffman and Patillo (2007) benefits to unmarked fish in fisheries with this mark rate and release mortality combination would be small at best.

5. DIT Marking, Sampling and Analysis

a. For the DIT analysis, CWT's recovered in 'Terminal First Nations' fisheries were included with escapement recoveries. Were these fisheries independently sampled in

the same manner as hatchery based operations? This would be helpful in more fully understanding the data quality associated with DIT escapement recoveries.

b. Presentation of the data from each DIT hatchery escapement sample would be useful to better understand the quality of the data and the amount of confidence that should be placed on inferences from these data, especially when they are aggregated. Nevertheless, Figures 13 to 19 seem to indicate a consistent benefit in unmarked escapement rates of MSF's.

c. The "large terminal MSF's" on Quinsam River and Inch Creek hatcheries, the two remaining Canadian DIT stocks is a concern. Although the authors indicate that there did not appear to be a difference with other DIT stocks in the years prior to 2007, this could be a concern going forward. Again, mark rates and target-species information at a finer scale than the entire fishery would be useful in helping to understand this dynamic.

d. The DIT methodology when it was originally conceived (ASFEC, 1995) anticipated that all fisheries and escapements would be sampled for coded wire tags. As the working paper notes, the lack of direct sampling in the recreational fishery means that only escapement sampling can be used to infer the differences in fishery impact of MSF's. There is also no direct estimate of marine survival and exploitation rate if fisheries are not directly sampled. This is a significant gap as it results in unverifiable inferences of exploitation rate differences on marked and unmarked fish, not to mention significant gaps in data required for stock status assessments and fisheries management.

e. Additional concerns with the DIT analytical approach adopted in the working paper include:

- Method of aggregation – DIT odds ratios are combined across all DIT hatchery stocks in a manner that isn't transparent. The inclusion of a larger number of DIT stocks in earlier years relative to the present and the make-up of those stocks is a concern. Part of this concern is the inclusion of the Robertson Creek hatchery stock which has a much different susceptibility to MSF's than Strait of Georgia and Fraser River DIT stocks.
- Marked ER – Derivation of the marked ER that forms the basis of the calculated unmarked ER is poorly documented. In addition, the method of aggregation of marked ER's is a concern, again especially because of the inclusion of the Roberston Creek hatchery stock in the aggregate.
- Unmarked ER – Setting the minimum unmarked ER to zero when it is calculated as negative sets an unrealistic lower bound. Given known encounter rates and release mortalities, some minimum level of unmarked fishery induced mortality should be expected, especially when mixed bag limit fisheries have been prosecuted. Setting the minimum unmarked ER to zero also has the impact of reducing the difference between the marked and unmarked ER which is one of the key metrics in evaluating the effectiveness of MSF's.

f. An alternative analytical approach that might alleviate at least some of the above the concerns, is described below. This approach would start with the modeled ER (assumed to be unmarked) for Interior Fraser River (IFR) Coho in Table 25 of the companion CSAS working paper to this one (Interior Fraser River Coho Marine Fishery Planning Model and Updated Exploitation Rates), and calculate the marked ER using the same formula at the bottom of page 6 of this working paper but re-arranged to calculate the marked ER.

$$ER_u = DIT_{odds} \times ER_m - (DIT_{odds} - 1)$$

(From page 6 of the working paper)

$$ER_m = \frac{ER_u + (DIT_{odds} - 1)}{DIT_{odds}}$$

This is the reverse of the method used in the working paper of calculating the unmarked ER from an estimated marked ER, but has the advantage of using a better documented and perhaps more reliable starting point, as well as retaining the most reliable and useful evaluation parameter in the analysis, the DIT odds ratio. This may not be an ideal method, however, since IFR Coho are distributed somewhat differently in marine fisheries than the DIT hatchery groups and there are still concerns with the DIT odds ratio aggregation method, but it would be an improvement over the method used to generate Table 4 in the opinion of the reviewer.

Table A, and Figures A and B summarize the results of this alternative analysis and compares them with the estimates in the working paper. Note that the average marked ER's for the two methods are similar while the unmarked ER is less by two percentage points in the alternative analysis reflecting the effect of the zero minimum ER in the working paper analysis. The most significant difference in the two methods is the much more stable, and some might say more realistic, unmarked ER's (IFR Coho) in the alternative approach. Some might also say that one should expect greater variability in the marked ER than the unmarked ER because of inter-annual differences in MSF fishing conditions.

Table A. DIT odds ratio, marked and unmarked ER's from the working paper and from the analysis described in Reviewer Comment 5.e.

Return Year	IFR ER[1] (unmarked)	Unmarked ER (in paper)	DIT odds ratio	Marked ER (calculated)	Marked ER (in paper)
1999	0.0295	0.00	1.18	0.178	0.08
2000	0.0295	0.06	1.04	0.067	0.10
2001	0.0295	0.08	1.06	0.084	0.14
2002	0.0295	0.00	1.13	0.141	0.11
2003	0.0264	0.00	1.18	0.175	0.15
2004	0.0240	0.00	1.26	0.225	0.14
2005	0.0281	0.05	1.28	0.241	0.25
2006	0.0247	0.00	1.22	0.201	0.08
2007	0.0236	0.03	1.25	0.219	0.22
2008	0.0201	0.19	1.04	0.058	0.22
2009	0.0314	0.12	1.09	0.111	0.19
2010	0.0442	0.00	1.11	0.139	0.09
2011	0.0467	0.03	1.16	0.178	0.17
2012	0.0206	0.00	1.16	0.156	0.09
2013	0.0345	0.26	0.98	0.014	0.25
Average	0.0295	0.05	1.14	0.146	0.15

[1] For the purpose of this alternative analysis only the IFR ER for 1999 to 2002 (in red) is set to the average of the IFR ER for 2003 to 2013.

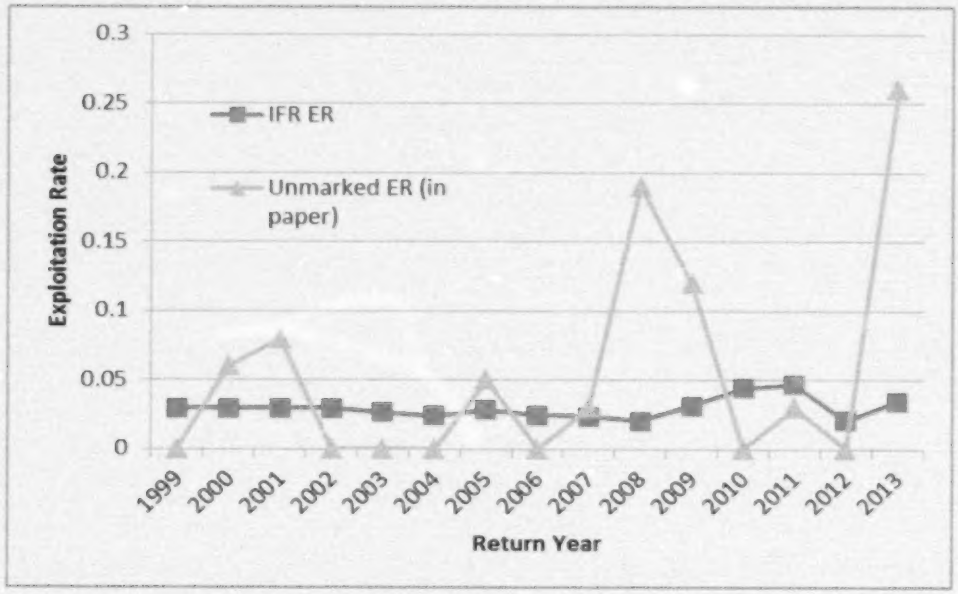

Figure A. Comparison of the unmarked ER calculated in the working paper with the Interior Fraser River Coho ER (assumed unmarked) from Table 25 in the companion working paper.

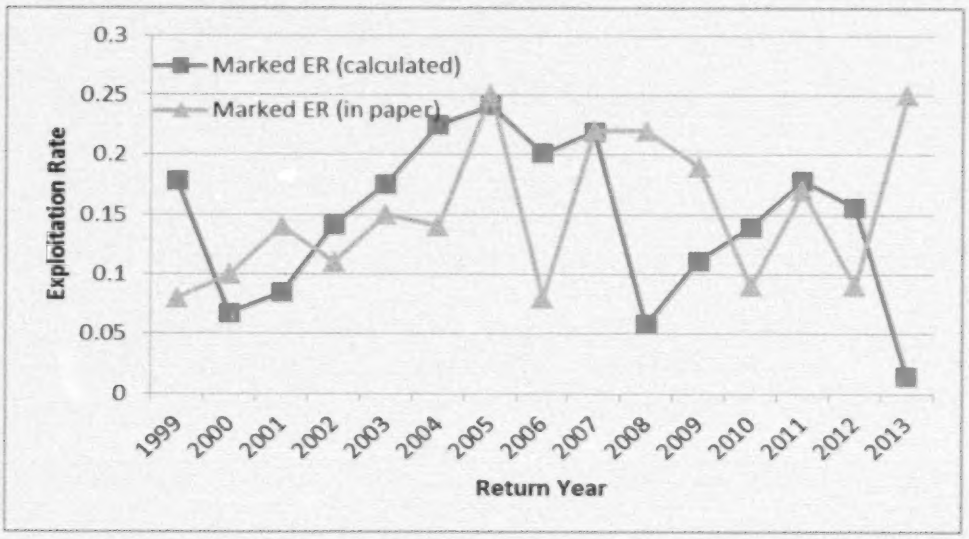

Figure B. Comparison of the marked ER in the working paper with the marked ER calculated as per Reviewer Comment 5.e above.

g. The ER benefit of MSF's is estimated at an average of 70% with a wide range among years (Section 3.3). Another way of presenting this benefit is to put it into the context of the difference between the average marked ER of 15% and the average unmarked ER of 5%. As noted in the paper, this magnitude of benefit of about 10 percentage points is consistent with a US analysis conducted in 2003 (Joint DIT Analysis Work Group, 2003). Using the alternative analysis above, a benefit of closer to 12 percentage points is estimated.

h. While gross comparisons of the DIT odds ratio with fishery mark rate are interesting, they should be interpreted with caution (Fig. 20). For example, in recent years Canada has only produced DIT tag groups for two hatchery stocks, one in the northern St. of Georgia and the other in the Lower Fraser River. Mass marked Coho contributing to MSF recreational and commercial fisheries come from a broader group of hatcheries, including significant numbers from the US. This would be particularly relevant for mark rates in Juan de Fuca and SWVI troll fisheries.

6. Evaluation

a. MSF's are one management tool available to fishery managers and are particularly suited to situations where mark rates are high relative to release mortality rates and where the alternative might be a complete fishery closure or non-retention regulations. Therefore, to say that they "appear entrenched" (first paragraph in Discussion) might be overstating the situation unless the comment is meant to indicate that MSF's will continue to be considered as a fisheries management option under the conditions noted. Clarification of this statement would be useful.

b. I agree with the conclusion in Section 4.3 that MSF's likely resulted in higher survival of unmarked fish than would have occurred in a non-selective retention fishery. However, as noted, the DIT escapement sampling was the most "informative" in drawing this conclusion and the degree of benefit, especially to recreational anglers, was less certain given the assumptions that had to be made in the analysis. Benefits of MSF's to commercial troll fisheries were even more uncertain.

c. Inferences about benefits to the recreational fishery from the data presented are difficult as noted in Section 4.2. Target-species data in Figure 8 are difficult to interpret without data at finer resolutions. For example, how did effort align with mixed bag versus MSF-only regulations? Similarly, the results in Table 7 should be interpreted with caution given the high quality retained catch data prior to 1998 being compared with post-1998 angler interview data. With respect to making inferences about potential benefits to anglers, Figure 3 which documents the time series of retained Coho in the recreational fishery is another indicator since presumably the post-1998 data are for marked fish only.

d. At the top of page 13 (Section 4.3), the authors highlight two short-comings that prevent their ability to develop estimates (presumably of exploitation rate but also marine survival) from DIT recoveries. The first is "a lack of catch estimates at the same temporal and spatial scale as MSF's in some recreational fisheries" and the second is "a lack of sampling for CWT's in unmarked fish in recreational fisheries". The reviewer agrees with these points and believes that they are significant in the broader context of future Coho salmon management.

e. The author's comment that based on a number of factors, the impact of MSF's on unmarked fish is likely low. The reviewer agrees with this conclusion, however, it should be noted that the only input parameter to this analysis that has been measured with any degree of certainty is the DIT odds ratio. Based on this analysis, the impact on marked fish, while higher than for unmarked fish, also appears to be low relative to previous non-selective fisheries. Estimates of Interior Fraser River Coho ER in the companion

working paper could be referenced to support this claim as the historical fishery catch distributions of these stocks and most DIT stocks are similar.

f. The reviewer agrees with the authors that to improve the ability to evaluate MSF's with greater certainty, additional DIT stocks should be developed, and that fisheries should be sampled in a non-biased manner. As noted, this will become even more important as mixed-bag MSF's and non-selective fisheries for Coho are considered.

g. An assertion is made at the end of the Discussion section that "The result is marked indicator stocks which over-estimate ER's for unmarked stocks." The basis for this assertion is not clear and it should be supported with an analysis.

h. Also at the end of the Discussion, the following statement would benefit from some elaboration; "Perhaps decisions to proceed with future MSF's should further consider the implications of being unable to meet higher resolution assessment goals and alternatives to estimating the ER's on unmarked fish." Does this refer to current catch monitoring and sampling programs? If so, these deficiencies may be independent of whether MSF's are conducted or not, but may be more a reflection of DFO budget priorities.

i. Presenting information and analysis on the level of compliance with MSF regulations may not have been within the scope of this working paper, but compliance level would play a role in the ultimate effectiveness of these regulations. Angler awareness of the variety of MSF regulations within a season could be an issue for compliance levels.

7. Summary

a. Coho MSF's appear to provide a survival advantage to unmarked fish over marked fish based on the DIT odds ratio in sampled hatchery escapements. The magnitude of this survival advantage is uncertain but may be in the order of 10 – 12 percentage points on a marked ER of 15%, averaged across all MSF fisheries.

b. Notwithstanding this survival advantage, the benefit of MSF's to recreational anglers is unclear. An exploitation rate of 15% on marked fish is well below the pre-MSF ER of approximately 25 to 50 percent in marine recreational fisheries under full retention regulations (Simpson et al, 2001). Further, the species-targeting on Coho fell to less than 10 percent in the post-full retention period beginning in 1998. As noted in the more detailed comments above, data on catch, mark rate and species targeting on a finer scale might help to assess the benefit to anglers more clearly and better inform future MSF application.

c. With respect to fishery analysis at finer temporal and spatial scales, discussion of the impacts of mixed-bag MSF fisheries and variable daily bag limits that have been occurring more frequently over time should be added to this working paper to permit a more complete evaluation.

d. DIT sampling and analysis in the working paper raises some concerns on the quality of a key input parameter, the ER for marked fish. The DIT odds ratio applied to estimated aggregate marked ER's in 7 out of 15 years resulted in a calculated unmarked ER of less than zero. The authors' solution to set those unmarked ER's to zero implies that there is an error in those years in the DIT odds ratio, which appears to be the highest quality data available to them. The alternative, more plausible explanation is that there might be an error in the estimated marked exploitation rates for those years, or perhaps

a more consistent bias across all years. An alternative analytical approach is suggested by the reviewer that starts with an estimate of unmarked ER for the Interior Fraser River Coho stock and calculates the marked ER using the same DIT odds ratio and formula in the working paper. (Note: Exploitation rate modeling for IFR Coho is the subject of the companion working paper to this one.)

e. While, the title of the working paper refers to "marine recreational fisheries", data on WCVI commercial troll fisheries are also provided. Based on the catch and fishery mark rates presented and the release mortality outlined in DFO's Integrated Fisheries Management Plan for salmon, there appears to be only a marginal benefit at best of MSF regulations in this fishery relative to non-selective retention.

f. Finally, it should be noted that when the DIT methodology was developed, sampling for marked and unmarked coded wire tagged fish was envisioned in both escapement and catch. Escapement sampling alone might be adequate when overall ER's are low and MSF regulations only permit marked fish to be retained. However, mixed-bag and non-selective retention regulations likely require more rigorous catch monitoring and sampling if statistically reliable ER, catch distribution and survival rate information is to be generated for management.

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APPENDIX C: AGENDA

Regional Peer Review Meeting (RPR)

Evaluation of Marine Recreational Coho Mark Selective Fisheries in British Columbia, including an evaluation of the Canadian marine fishery exploitation model for Interior Fraser Coho

March 3-5, 2015

Vancouver Island Conference Centre
Nanaimo, British Columbia

Chair: Marilyn Hargreaves

Working Paper #1
Interior Fraser River Marine Fishery Planning Model and Updated Exploitation Rates

DAY 1 - Tuesday, March 3rd, 2015

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping CSAS Overview and Procedures	Chair
0915	Review Terms of Reference Objectives for Working Paper #1	Chair
0930	Presentation of Working Paper	Wilf Luedke Pieter Van Will
1030	***Break***	
1045	Written Reviews & Response	Michael Staley Bill Gazey Authors
1140	Identification of Key Issues for Group Discussion	RPR Participants
1200	***Lunch Break***	
1300	Discussion & Resolution of Technical Issues	RPR Participants
1445	***Break***	
1500	Discussion & Resolution of Technical Issues	RPR Participants
1700	Adjourn for the Day	

DAY 2 - Wednesday, March 4th, 2015

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping Review Status of Day 1	Chair
0915	Discussion & Resolution of Overarching Working Paper Issues	RPR Participants
1030	***Break***	
1045	Develop Consensus on Paper Acceptability & Agreed-upon Revisions	RPR Participants
1100	<u>Science Advisory Report (SAR)</u> Develop consensus on the following for inclusion: • Key Sources of Uncertainty to highlight • Key Conclusions • Advice	RPR Participants
1150	Next Steps – Chair to review • SAR review/approval by participants and timelines • Research Document & Proceedings timelines • Other follow-up or commitments (*as necessary)*	Chair
1200	***Lunch***	

Day 2 - Working Paper #2
Evaluation of Marine Recreational Coho Mark-Selective Fisheries

(Note: The presentation of Working Paper #2 may begin earlier pending the review of Working Paper #1)

Time	Subject	Presenter
1300	Introductions & Agenda	Chair
1310	Review Terms of Reference Objectives for Working Paper #2	Chair
1320	Presentation of Working Paper	Dave O'Brian
1400	Presentation of Written Reviews	Ron Kadowaki Mike Hawkshaw
1430	***Break***	
1445	Written Reviews Response	Authors
1515	Identification of Key Issues for Group Discussion	RPR Participants

Time	Subject	Presenter
1530	Discussion of Key Technical Issues	Chair
1700	***Adjourn for the Day***	

DAY 3 - Thursday, March 5th, 2015

Time	Subject	Presenter
0900	Review Agenda & Housekeeping Review Status of Day 2	Chair
0915	Discussion & Resolution of Technical Issues	RPR Participants
1030	***Break***	
1045	Discussion & Resolution of Results & Conclusions	RPR Participants
1230	***Lunch Break***	
1330	Develop Consensus on Paper Acceptability & Agreed-upon Revisions	RPR Participants
1400	<u>Science Advisory Report (SAR)</u> Develop consensus on the following for inclusion: • Results & Conclusions • Sources of Uncertainty • Additional advice to Management (*as warranted*)	RPR Participants
1445	***Break***	
1500	<u>Science Advisory Report (SAR)</u> • Continued	RPR Participants
1600	Next Steps – Chair to outline: • SAR review/approval process and timelines • Timelines for other documents • Other follow-up or commitments required	RPR Participants
1645	Concluding Remarks • Other business arising from the review	Chair & RPR Participants
1700	***Adjourn meeting***	

APPENDIX D: PARTICIPANTS

Last Name	First Name	Affiliation
Ashton	Chris	Commercial Salmon Advisory Board
Bailey	Richard	DFO Science Fraser River
Baillie	Steve	DFO Science South Coast
Campbell	Kelsey	JTWG/A-Tlegay Fisheries/IMAWG
Candy	John	DFO Science
de Mestral Bezanson	Louise	DFO Fisheries Management Fraser River
Dobson	Diana	DFO Science South Coast
Dunlop	Roger	PST Coho Technical Committee
Fraser	Kathy	DFO Science
Galbraith	Ryan	DFO Salmon Enhancement Program
Gazey	Bill	W.J. Gazey Research
Hawkshaw	Mike	Contract - Author
Hawkshaw	Sarah	UBC Fisheries Centre
Houtman	Rob	DFO Science
Irvine	Jim	DFO Science
Kadowaki	Ronald	DFO Fisheries Management
Komick	Nicholas	DFO Science
Kristianson	Gerry	Sports Fishing Advisory Board
Laliberte	Bernette	Cowichan Tribes
Lemieux	Jeffrey	DFO Science Freshwater
Luedke	Wilf	DFO Science South Coast
Lynch	Cheryl	DFO Salmon Enhancement Program
MacDougall	Lesley	DFO Science CSAP
Mahoney	Jason	DFO Salmon Enhancement
Maynard	Jeremy	Sports Fishing Advisory Board / Southern Panel - Rec fishing rep
McGrath	Elinor	Okanagan Nation Alliance
Nicklin	Pete	Upper Fraser Fisheries Conservation Alliance & PST Coho Technical Committee
O'Brien	David	DFO Science South Coast
Ormond	Chad	QARS
Parken	Chuck	DFO Science Fraser River
Ritchie	Lynda	DFO Science Fraser River
Rosenberger	Andrew	Raincoast Conservation Foundation/MCC
Sawada	Joel	DFO Science
Scanlan	Marilyn	Southern Panel - Rec fishing rep
Schweigert	Jake	DFO, retired
Scroggie	Jamie	DFO Fisheries Management Fraser River
Sheng	Mel	DFO SEP Enhancement Operations
Singer	Kris	DFO Fraser River
Staley	Mike	Fraser River Aboriginal Fisheries Sec.
Thiess	Mary	DFO Science SAFE Core

Last Name	First Name	Affiliation
Tompkins	Arlene	DFO Science SAFE Core
Urquhart	Jessica	JTWG
Van Will	Pieter	DFO Science South Coast
Walsh	Michelle	Shuswap Nation
Whitehouse	Timber	DFO Science Fraser River